ratio of at least 5, more preferably at least 10, more preferably at least 20. The height is perpendicular to net flow and width is perpendicular to height and length (length is direction of net flow through a channel). Plural (preferably a planar array) process channels and coolant channels (also preferably arranged in planar array; preferably interleaved planar arrays of process and cooling channels) are cross-flow relative to process channels. Coolant channels have horizontal flow (at least 50% of the flow length is oriented horizontally). Varying cross-section of cooling channel with a relatively large gap (at least 10% greater cross-sectional area) at the front of cooling channel where fluid is not boiling, relatively smaller cross-section in partial boiling region; and, optionally, a relatively large cross-sectional area near end of cooling channel. Flow distribution to multiple parallel channels as is discussed herein. Use of barriers that form an orifice diameter that is greater than 10% of a connecting channel hydraulic diameter, in other preferred embodiments >20%, >40%, >50% (orifice may be at entrance area or constricted opening; one-to-one barrier to channel), preferred lengths of orifice; preferably at least 50 micrometers, not more than 90% of channel. Fouling in headers or footers of a microchannel partial boiling channel if TDS>1 ppm (caused by a low flow rate in headers, while channels see a high velocity). Flow distributed to at least 4 or more zones across the inlet face of the array of parallel microchannels for a first distribution, prior to a second distribution into an array of at least 4 more parallel microchannels (see, for example, the low-P vaporizer example).

[0135] Partial boiling is defined as a process to vaporize a liquid to achieve a liquid-vapor mixture.

[0136] Exothermic reactions include: Fischer-Tropsch reaction; alkylation; oxidation to an oxygenate or nitrile; dimerization; polymerization; hydrogenation, hydrodesulfurization, hydrotreating, or hydrocracking; direct combination of hydrogen and oxygen to hydrogen peroxide.

[0137] Exothermic processes comprise unit operations which release energy, including separations such as absorption or adsorption, phase transformations, and exothermic chemical reactions.

[0138] In various aspects, the invention includes an exothermic process that transfers heat to a channel (of 10 mm or less) that comprises a boiling fluid, and may include any of the following concepts or any combination of these concepts:

[0139] A process comprising partial boiling in a microchannel with a chemical reaction in an adjacent reaction chamber;

[0140] A process comprising partial boiling in a microchannel with a chemical reaction in an adjacent reaction microchannel;

[0141] A process comprising partial boiling in a microchannel with a chemical reaction in an adjacent reaction chamber, whereby the catalyst temperature rises less than 30 C (more preferably less than 10 C, less than 5 C, less than 3 C) along the length of the reaction chamber and the reaction contact time is less than 300 ms;

[0142] A process comprising partial boiling in a microchannel with a process comprising a phase change in an adjacent process chamber;

[0143] A process comprising partial boiling in a microchannel with a process comprising a phase change in an adjacent process microchannel;

[0144] A process comprising partial boiling in a microchannel with a process comprising a distillation of a fluid mixture comprising at least two fluid components in an adjacent process microchannel;

[0145] A process comprising partial boiling in a microchannel with a process comprising a phase change in an adjacent process chamber, whereby the temperature rise is less than 10 C in the process chamber;

[0146] A process comprising partial boiling in a microchannel with a mixing process in an adjacent process chamber;

[0147] A process comprising partial boiling in a microchannel with a mixing process in an adjacent process microchannel;

[0148] A process comprising partial boiling in a microchannel with a mixing process in an adjacent process chamber, whereby the temperature rise in the mixing chamber is less than 5 C;

[0149] A process comprising partial boiling in a microchannel with a fermentation process in an adjacent process chamber;

[0150] A process comprising partial boiling in a microchannel with a fermentation process in an adjacent process microchannel;

[0151] A process comprising partial boiling in a microchannel with a fermentation process in an adjacent process chamber, whereby the temperature rise in the mixing chamber is less than 10 C;

[0152] A process comprising partial boiling in a microchannel with a absorption process in an adjacent process chamber, whereby the temperature rise in the absorption chamber is less than 10 C; wherein there is a temperature range of 5 C or less over at least 80% of the cycle time for thermal swing adsorption; wherein there is a temperature range of 5 C or less over at least 80% of the time for desorption.

[0153] Partial boiling process in a microchannel with >10 channels and a flow distribution quality factor <20%; more preferably less than 10%; and still more preferably less than 5%.

[0154] A process comprising partial boiling in a microchannel with an adsorption process in an adjacent chamber; and/or

[0155] A process comprising partial boiling in a microchannel with an adsorption process in an adjacent microchannel.

[0156] In various aspects, the invention includes an exothermic process that transfers heat to a microchannel that comprises a boiling fluid that has dissolved solids (for example, tap water), and may include any of the following concepts or any combination of these concepts: Partial boiling process in a microchannel with more than 3 cycles where heat exchanger efficiency varies by less than 2% as compared before and after cycle in the range 0.01 ppm>TDS boiling fluid<15 ppm; Partial boiling process in a micro-